REMARKS

This Preliminary Amendment cancels the original claims, without prejudice, in the underlying PCT Application No. PCT/DE2004/001631. The Preliminary Amendment also adds new claims 15-28. The new claims conform the claims to U.S. Patent and Trademark Office rules and do not add new matter to the application.

In accordance with 37 C.F.R. § 1.125(b), the Substitute Specification (including the Abstract) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to conform the Specification and Abstract to United States Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. §§ 1.121(b)(3)(ii) and 1.125(c), a Marked-Up Version of the Substitute Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. Approval and entry of the Substitute Specification (including Abstract) are respectfully requested.

The underlying PCT Application No. PCT/DE2004/001631 includes an International Search Report, dated December 9, 2004, a copy of which is submitted herewith.

Applicants assert that the subject matter of the present application is new, non-obvious, and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully submitted,

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DEVICE FOR DETECTING MOVING OBJECTS

Field Of The Invention

The present invention relates to a device for detecting moving objects present in a vehicle's blind-spot, the device having at least one object detection sensor which, when the driver backs out of a parking space, detects the distance to objects moving at an angle to the vehicle and

5   sends that information to an evaluation unit, and, based on the distance data sent to it, the evaluation unit determines the relative velocity, and as a function of the distance, the relative velocity, and the velocity of the driver's vehicle, a warning device is switched on which informs the driver of the object moving at an angle to his own vehicle.

Background Information

10   An ultrasonic parking assistance device which assists the driver of a vehicle when parking in a parking space is known from the book *Autoelektrik, Autoelektronik* [Automotive Electrical Systems, Automotive Electronics], Vieweg Verlag, 1998, pp. 283-285 (chapter entitled "Parking Systems").

Furthermore, systems which monitor a vehicle's blind spot and inform the driver if an object is

15   detected in the blind spot are known from the related art. Such a device is known heretofore for example from ~~DE~~*German Published Patent Application No.* 42 28 ~~794 A1.~~*794.*

~~Object and Advantages of the~~*Summary Of The* Invention

The object of the present invention is to further enhance a device in a motor vehicle suitable for detecting objects in a blind spot so that when the driver backs out of a parking space, the device

20   detects vehicles moving at an angle and not only warns the driver but also assists him via other functions~~. According to the present invention, this object is achieved via the features set forth in the independent claim. Advantageous further refinements and embodiments are indicated in the dependent claims~~.

It is advantageous that as a function of the distance, the relative velocity, and the velocity of the

25   driver's vehicle, the deceleration devices may be switched on by the evaluation device.

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Furthermore it is advantageous that, using the evaluation device, the distance between the object moving at an angle and adjacent parked vehicles may be determined from the distance and relative velocity of the object moving at an angle to the driver's vehicle.

It is advantageous that the object detection sensor is a radar sensor, an ultrasonic sensor, a laser sensor, a video sensor, or a combination thereof.

It is advantageous that the radar sensor is designed as a pulse radar sensor.

Furthermore, it is advantageous that the at least one object detection sensor is integrated into the vehicle's bumper so that it is not visible from the outside.

It is advantageous that the object detection sensor is mounted on vehicle corners at an angle of approximately 45° to the vehicle's longitudinal axis.

Furthermore, it is advantageous that if the vehicle is being backed out of a parking space, the warning function is enabled when the driver engages the reverse gear.

Furthermore, it is advantageous that if the vehicle is backed out of a parking space, the warning function is enabled when the engine is switched on and the vehicle is still stationary.

Furthermore, it is advantageous that if the vehicle is backed out of a parking space, the warning function may be temporarily disabled via a driver-operated actuator until the function is used again.

According to a further embodiment of the present invention, a display unit is able to notify the driver whether the device is enabled.

It is advantageous that the evaluation device is able to issue a warning if the velocity of the driver's vehicle exceeds a predefined velocity threshold.

Furthermore, it is advantageous that the warning device provides the driver with a visual, acoustic, or visual and acoustic warning.

~~Further features, applications, and advantages of the present invention are indicated below in the description of exemplary embodiments of the present invention, which are shown in the drawing. Herein, all features described or shown, either per se or in any combination, constitute the subject matter of the present invention, regardless of how they are summarized in the patent~~

~~Drawing~~

5 ~~basis of the drawing.~~

Brief Description Of The Drawings

Figure 1   shows an exemplary traffic situation in which the device according to the present invention may advantageously be used~~;~~.

Figure 2   shows a schematic block diagram of an exemplary embodiment of the device

10 according to the present invention~~, and~~.

Figure 3   shows a flow diagram as provided in the device according to the present invention.

Detailed Description ~~of the Exemplary Embodiments~~

Figure 1 shows a traffic situation in which the driver's vehicle 1 is backed out of a parking

15 space, further vehicles 2 being parked next to the driver's vehicle 1. A vehicle 3 traveling at an angle past parked vehicles 2 and thereby endangering the driver's vehicle 1 is also shown. According to the present invention, the driver's vehicle 1 is equipped with at least one object detection sensor 4; in the example shown, vehicle 1 has a total of four object detection sensors. Object detection sensors are situated on the rear of vehicle 1 so that one sensor is provided on

20 each rear vehicle corner and so that their main sensor axis 6 is at a 45° angle to the vehicle's longitudinal axis. Two additional object detection sensors 4 are situated on the rear, their main sensor axis 6 being parallel to the vehicle's longitudinal axis. This creates a detection area, as shown by the four sensor detection areas 5, in that sensor detection areas 5 partly overlap and thus cover the entire rear space behind vehicle 1, and also cover areas adjacent to and behind

25 the rear space. The sensors are able to determine the distance to detected objects in sensor detection area 5 and their relative velocity. It is also feasible for sensors 4 to measure only the distance between objects and the driver's vehicle 1, the relative velocity of detected objects 3 being derived by generating the difference quotient based on the time from the distance. Furthermore, it is feasible to determine a distance e at which passing vehicle 3, which has been

30 detected as an object, is passing the rear end of the driver's vehicle 1. Distance e is the perpendicular distance between the rear end of the driver's vehicle 1 and the extended line of

travel of passing vehicle 3. Calculation of distance e is described in greater detail in Figure 3. According to the present invention, the device is enabled when the vehicle's ignition is switched on or when the reverse gear is engaged while the ignition is switched on. If this switch-on condition is met, the device determines that the driver wishes to back up his vehicle

5   1, e.g. back it out of a parking space. If these switch-on conditions have been met, the sensors are enabled and use ultrasonic waves, radar waves, laser radiation, or an imaging system to measure the distance to objects which are present in sensor detection areas 5 or are entering those areas. If a vehicle 3, which is for example traveling at an angle past parked vehicles 2 and has not been noticed by the driver of vehicle 1, is detected according to the present invention,

10   an evaluation unit to which these signals from object detection sensors 4 are sent issues an acoustic, visual, or acoustic and visual warning signal to alert the driver that a vehicle 3 traveling at an angle has been detected. Furthermore, it is feasible for the evaluation unit to switch on the deceleration devices of vehicle 1 and apply the brakes of vehicle 1 until it is stationary, in order to avoid a collision with vehicle 3 traveling at an angle.

15   Figure 2 shows a block diagram. Control device 7, which has among other things input circuit 8, is shown in the figure. Input signals are sent via input circuit 8 to control device 7. The signal of at least one of object detection sensors 4 is supplied as the input signal; in the example shown, vehicle 1 has four such object detection sensors, which send their signals to input circuit 8. Furthermore, a velocity signal from speed sensor 9, which measures the velocity of the driver's

20   vehicle 1 and sends it to control device 7, is sent to input circuit 8. Moreover, further signals may be sent to input circuit 8, e.g., switch-on or switch-off signals or control signals from driver-operated actuators or a reversing signal from reversing switch 10, which determines whether the vehicle's reverse gear has been engaged. It is also feasible for a signal to be sent to input circuit 8 as soon as the vehicle's ignition has been switched on. Input circuit 8 sends the

25   input signals via data exchange system 11 to calculation device 12, in which manipulated-variable signals are determined from the input signals and sent to subordinate actuating elements and controlled as a function of the input signals. The manipulated-variable signals determined by calculation device 12 are sent via data exchange system 11 to output circuit 13, which triggers for example a visual distance display unit 14, which indicates the

30   distance of the detected object or the danger presented by the detected object. This may be accomplished for example via colored LEDs, an increasing number of LEDs being turned on as the level of danger increases. Furthermore, output circuit 13 may switch on an acoustic warning device 15, which uses a warning sound or spoken instructions to alert the driver about

the imminent danger posed by detected objects. In the case of activation of acoustic warning device 15 or visual distance display unit 14, it is advantageous that not only distance d_n from the detected object to the driver's vehicle 1, but also relative velocity v_{rel} of the moving object and perpendicular distance e from perpendicularly passing vehicle 3 to the rear end of vehicle 1

5   are used to determine danger potential G, and the warning devices are switched on as a function of danger potential G. For example, if perpendicularly passing vehicle 3 is traveling at a high relative velocity, danger potential G increases, and a small distance e also results in an increase in danger potential G. Danger potential G also increases if distance d_n between perpendicularly passing vehicle 3 and the driver's vehicle 1 decreases. Furthermore, it is feasible for the driver

10   of vehicle 1 to temporarily disable control device 7 via a driver-operated actuator, e.g., this warning function is disabled for the imminent reversing-out procedure but is available again for the next backing-out procedure. Moreover, it is feasible for control device 7 to trigger the vehicle's deceleration devices 16, so that for example if the danger potential is high due to perpendicularly passing vehicle 3, vehicle 1 is automatically braked to a standstill.

15   Figure 3 shows a flow diagram indicating the function according to the present invention. After the start of the function, which is triggered for example by engaging the reverse gear or switching on the vehicle ignition, the vehicle's own velocity V_e is input in first step 17. In next step 18, distance d_n to an object present in object detection area 5, e.g., a perpendicularly passing vehicle 3, is determined. This may be accomplished via pulse radar and a propagation

20   time measurement. In next step 19, relative velocity v_{rel} of perpendicularly passing vehicle 3 with regard to object detection sensor 4 of vehicle 1 is determined from calculated distance d_n and from calculated distance $d_n - 1$, which was determined in the preceding measuring cycle. To accomplish this, distance $d_n - 1$ is subtracted from d_n and divided by the time value Δt, time value Δt being the time between two measuring pulses, i.e., two immediately consecutive

25   measuring pulses. In next step 20, modified relative velocity V_{relmod} is determined from the calculated relative velocity, velocity V_e of the vehicle multiplied by a factor f being subtracted from calculated relative velocity V_{rel}. It is advantageous if factor f is no greater than 0.7, though it may also be less than that. Because velocity V_e of vehicle 1 multiplied by factor f is subtracted, the calculation of modified relative velocity V_{relmod} takes into account the velocity

30   of the vehicle V_e, thereby reducing the likelihood of erroneous warnings associated with stationary objects in the perpendicular direction. In the next step 21, distance e is determined, which represents the perpendicular distance between the extended line of travel of perpendicularly passing vehicle 3 and the rear of the driver's vehicle 1. Assuming that the

velocity of detected object 3 is constant between two measurement intervals, and that distance e is also constant over the time between two measurement intervals, and also assuming that velocity V_e of the driver's vehicle is negligible with regard to total relative velocity V_{rel}, the azimuthal angle at which passing vehicle 3 is moving towards vehicle 1 may be determined

5   approximately from the change in relative velocity V_{rel} which arises as a result of the changing azimuthal angle. Distance 3 may also be determined in this way, and is calculated as follows subject to the aforementioned assumptions:

$$e = \frac{d_n}{v_e} * \sqrt{v_e^2 - v_{relmod}^2}$$

This distance e is used when danger level G is determined, distance d_n between object 3 and

10   vehicle 1, as well as modified relative velocity V_{relmod}, also being taken into account.

Because only low velocities of vehicle 1 are permitted for the procedure described, as the calculation method's capability threshold would otherwise be exceeded, a check is performed in step 22 to determine whether the velocity of the driver's vehicle V_e is greater than a predefinable maximum velocity value V_{max}, which is definable as for example $V_e = 6$ km/h. If

15   velocity V_e of vehicle 1 is greater than this predefinable velocity threshold V_{max}, the method branches in block 22 to "Yes" and in block 23 a warning is issued to notify the driver that the velocity V_e of vehicle 1 is too great and the system's capability threshold has been exceeded. This driver warning may for example be acoustic or visual, or according to a further embodiment, the vehicle is automatically limited to a maximum velocity value V_{max}, e.g., via a

20   trigger from deceleration devices so that V_{max} is not exceeded or via automatic throttling of the engine output of vehicle 1. If it is determined in block 22 that velocity V_e of vehicle 1 is less than or equal to maximum velocity threshold V_{max}, the method branches in block 22 to "No" and in block 24 danger level G is determined as a function of distance d_n, modified relative velocity V_{relmod}, velocity V_e, and distance e of perpendicularly passing object 3 from the objects

25   2 that delimit the road. To accomplish this, for example the anticipated future movements of the driver's vehicle 1 and of perpendicularly passing vehicle 3, and a time period until a calculated collision, or a path leading to a calculated collision, may be determined. As a function of the remaining time or remaining path, or if danger level G is exceeded beyond a boundary threshold G_{max}, an acoustic or visual driver warning is issued per block 25.

30   Furthermore, it is also feasible to trigger the deceleration means of vehicle 1 in addition to an acoustic, visual, or acoustic and visual driver warning, so that a collision with perpendicularly

passing vehicle 3 may be avoided. After block 23 or block 25, the method branches to END and starts again at START by way of an endless loop, provided the predefined enable conditions for the warning function are met. These conditions may be for example that the vehicle's reverse gear is engaged. If, when the backing-out maneuver has been completed, a gear is engaged that moves the vehicle forward, the process is ended and normal driving operation begins, the sensor being used for example for blind-spot detection only.

Abstract *Of The Disclosure*

A device for detecting moving objects present in the blind spot of a vehicle (1), the device having at least one object detection sensor (4), which, when the vehicle (1) is backed out of a parking space, detects the distance (d_n) between objects moving at an angle to the vehicle (1)

5   and sends it to an evaluation unit (7), and the evaluation unit (7) determines the relative velocity (V_{rel}) from the distance (d_n) sent to it, and a warning device is switched on as a function of the distance (d_n), the relative velocity (V_{rel}) and the velocity of the driver's vehicle (V_e) to notify the driver of the object (3) moving at an angle to the driver's vehicle (1).

10   (Figure 1)